

FORM PCT-100 (REV. 10-90)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE ATTORNEY'S DOCKET NUMBER	
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		RCA 88423	
INTERNATIONAL APPLICATION NO PCT/US97/18167		INTERNATIONAL FILING DATE 08 October 1997 (08.10.97)	PRIORITY DATE CLAIMED 08 October 1996 (08.10.96)
TITLE OF INVENTION DIGITAL RECORDER WITH TRICK PLAY OPERATION			
APPLICANT(S) FOR DO/EO/US Harold Blatter, Karl Francis Horlander, Michael Joseph McLane			
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information			
<ol style="list-style-type: none"> <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371. <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371. <input checked="" type="checkbox"/> This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1). <input checked="" type="checkbox"/> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2)) <ol style="list-style-type: none"> <input type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau). <input checked="" type="checkbox"/> has been transmitted by the International Bureau. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US). <input type="checkbox"/> A translation of the International Application into English (35 U.S.C. 371(c)(2)). <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)) <ol style="list-style-type: none"> <input type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau). <input checked="" type="checkbox"/> have been transmitted by the International Bureau. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired. <input type="checkbox"/> have not been made and will not be made. <input type="checkbox"/> A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)). <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). <input type="checkbox"/> A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)). 			
Items 11. to 16. below concern document(s) or information included:			
11. <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98 with references attached.			
12. <input checked="" type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included			
13. <input checked="" type="checkbox"/> A FIRST preliminary amendment. <input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment			
14. <input type="checkbox"/> A substitute specification.			
15. <input type="checkbox"/> A change of power of attorney and/or address letter			
16. <input type="checkbox"/> Other items or information:			
EJ648050926US		CERTIFICATE OF MAILING UNDER 37 CFR 1.10 March 30, 1999	
"Express Mail" mailing no.		Date of Deposit	
I hereby certify that this application is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.			
David A Fornarotto		David Fornarotto	
Typed or printed name of person mailing application		Signature of person mailing application	

097269684 INTERNATIONAL APPLICATION NO PCT/US97/18167 ATTORNEY'S DOCKET NUMBER RCA 88423

17 ☒ The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5)):
 Search Report has been prepared by the EPO or JPO \$840.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) \$670.00
 No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.443(a)(2)) \$760.00
 Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.443(a)(2)) paid to USPTO \$970.00
 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) \$96.00

ENTER APPROPRIATE BASIC FEE AMOUNT = \$ 970.00

Surcharge of \$130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE
Total claims	9 -20 =	0	X 18.00
Independent claims	4 -3 =	1	X 78.00
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			250.00

TOTAL OF ABOVE CALCULATIONS = \$ 1048.00

Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28).

SUBTOTAL = \$ 1048.00

Processing fee of \$130.00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).

TOTAL NATIONAL FEE = \$ 1048.00

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property + \$ 40.00

TOTAL FEES ENCLOSED = \$ 1088.00

Amount to be:
 refunded \$
 charged \$ 1088.00

a. ☐ A check in the amount of \$_____ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. 07-0832 in the amount of \$1088.00 to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 07-0832. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO
 Mr. Joseph S. Tripoli
 THOMSON MULTIMEDIA LICENSING INC.
 PO BOX 5312
 Two Independence Way
 Princeton, New Jersey 08543

SIGNATURE
Francis A. Davenport
 NAME
36,316
 REGISTRATION NUMBER

SCAN 3
00

80 Rec'd PCT/PTO 30 MAR 1999

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Harold Blatter, Karl Francis Horlander,
Michael Joseph McLane

Filed : Herewith

For : DIGITAL RECORDER WITH TRICK PLAY
OPERATION

PRELIMINARY AMENDMENT

Hon. Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

In the US national phase application of
PCT/US97/18167 filed herewith, please enter the following
amendments.

IN THE ABSTRACT:

Please add the attached Abstract.

REMARKS

To meet the requirements of the United States, the
Abstract (as originally filed in the PCT application) is added.

No fee is believed to have been incurred by virtue of this amendment. However if a fee is incurred on the basis of this amendment, please charge such fee against deposit account 07-0832

Respectfully submitted,
Harold Blatter
Karl Francis Horlander
Michael Joseph McLane

Francis A. Davenport
Francis A. Davenport/
Registration No. 36,316
609/734-9864

THOMSON multimedia Licensing Inc.
Patent Operation
PO Box 5312
Princeton, NJ 08543-5312

Date: MAR 30 1999

March 30th 1999.

ABSTRACT OF THE DISCLOSURE

A record and replay apparatus comprises a transducing
5 means for reproducing a digital signal from a medium. A control
means controls a reproduction mode of the apparatus. A decoding
means is coupled to the transducing means for decoding the digital
signal and deriving therefrom a signal indicative of a specific picture
type. The reproduction mode has a first period of reproduction at a
10 normal play speed and a second period of reproduction at a speed
greater than the play speed. The first and second periods alternating
with the first period initiated responsive to the signal indicative of a
specific picture type. In a further arrangement a first transducing
means records an MPEG signal. A control means generates a signal,
15 indicating an intra coded frame occurrence in the MPEG bit stream,
which is recorded by a second transducing means together with a
servo reference signal.

DIGITAL RECORDER WITH TRICK PLAY OPERATION

This invention relates to the field of digital video recording and in particular to reproduction at speeds other normal.

BACKGROUND OF THE INVENTION

5 A digital video signal may be processed to form a bit stream having a reduced bit rate. Such processing for bit rate reduction may be implemented according to an MPEG compression method, and may be formatted for example, with a structure, such as that employed in a digital satellite system, for example DSS™ or the
10 proposed Grand Alliance or GA terrestrial system.

A consumer video recorder may be adapted to provide recording capabilities for both analog signals and digitally encoded signals processed for example, for compatibility with an MPEG standard and having for example GA or DSS™ signal formats. The
15 adapted consumer video recorder may be considered as two electronic systems within one box, sharing a recording mechanism, servo and control systems. A conventional analog recording method may be employed where an analog luminance signal component frequency modulates an RF carrier and an analog chrominance signal
20 component amplitude modulates a second RF carrier. When reproduced, the two modulated signals are demodulated, combined and coupled for video display.

Digital recording may be achieved by employing the consumer video recorder as a digital bit stream recorder/player. The
25 MPEG compatible bit stream, for example transport packets, may be recorded by reformatting and processing to facilitate recording and reproduction. In a playback mode the recording processes are effectively reversed, and the bit stream is restored to have the original MPEG format and time relationships.

30 The material cost of a consumer digital recorder may be minimized by the omission of MPEG processing or decoding. Thus, the recorder records and replays the MPEG packet stream without changes or additions. Hence the consumer digital recorder functions as a bit stream recorder for program delay or time shifting usage.

35 The MPEG compression method employs intra coded frames, or I frames, forward predicted frames, or P frames and a bidirectionally predicted frames, or B frames. These three types of

00269684-03309

-2-

frames occur in groups known as Groups Of Pictures or GOPs. The number of frames in a GOP is user definable but may comprise, for example, 12 or 15 frames. Each GOP contains one I frame, which for transmission is abutted by a P frame which is followed by a sequence of B and P frames. Only I frame data may be decoded independently of any other frame, P frames may be predicted from a preceding I or P frame. Bi-directionally predicted frames or B frames require prediction from surrounding I or P frames.

In an analog consumer VCR, trick play features, such as picture in forward or reverse shuttle, fast or slow motion, are readily achievable, since each recorded track typically contains one field with adjacent tracks containing similar, but temporally off set images. Reproduction at speeds other than the recorded speed result in the reproducing head, or heads, crossing multiple tracks, and recovering recognizable picture segments. However, when an MPEG signal is recorded, the I, P and B frames of each GOP occupy adjacent tracks. When replayed at play or normal speed, the I frame data must be recovered first in order to permit the reconstruction of succeeding P and B frames. When the MPEG recording is replayed at a speed different to normal speed the replay heads transduce sections or segments from multiple tracks. However, these replayed segments contain parts of a GOP which, unlike the analog recording condition, no longer represent sections of discrete records from consecutive images. Instead, the transduced segments contain data resulting mainly from predicted P and B frames of the GOP. Clearly, since during trick play operation the amount of I frame data replayed progressively diminishes as the trick play speed increases, there is little possibility of decoding P and B frames from the reproduced pieces of I frame data. In addition, if the replayed I frame data is to be decoded it must comply with the syntax required by the MPEG standard. Thus, in a consumer digital recorder which does not process the MPEG stream to redistribute I frame data or form trick play data for redundant recording, reproduction at other than normal play speed may be precluded.

- 3 -

SUMMARY OF THE INVENTION

A record and replay apparatus comprises a transducing means for reproducing a digital signal from a medium. A control means for controls a reproduction mode of the apparatus. A decoding means is coupled to the transducing means for decoding the digital signal and deriving therefrom a signal indicative of a specific picture type. The reproduction mode has a first period of reproduction at a normal play speed and a second period of reproduction at a speed greater than the play speed. The first and second periods alternating with the first period initiated responsive to the signal indicative of a specific picture type.

In a further inventive embodiment a record and replay apparatus is coupled at an input to a source of an MPEG bit stream signal for recording. A first transducing means records and reproduces a digital signal representative of the MPEG bit stream. A control means is coupled to the MPEG bit stream signal and generates a signal indicating an intra coded frame occurrence in the MPEG bit stream. A second transducing means records and reproduces a servo reference signal. A generating means is responsive to the indicating signal for generating a identifying signal for recording with said servo reference signal.

In yet a further inventive embodiment a recording and replay apparatus has a trick play reproduction mode comprising the steps of:

- a) initiating a play mode for I frame reproduction from a recorded media;
- b) initiating a fast play mode to pass the recorded media;
- c) resuming the play mode for reproduction of a subsequent I frame from the media; and,
- d) controlling transitions between the play and said fast play modes responsive to a fast play mode predetermined sequence.

In another inventive embodiment a recording and replay apparatus has a trick play reproduction mode comprising the steps of:

- a) initiating a play mode;
- b) determining an average number of control track pulses occurring between I frames;
- c) selecting a trick play mode;

09269634.033009

- 4 -

- d) counting control track pulses to determine an average value;
- e) testing a count for equality with the average number; and,
- f) initiating said play mode at count equality.

5 BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 depicts an exemplary block diagram including various inventive embodiments.

FIGURE 2A shows tracks recorded on a medium employing inventive embodiments.

10 FIGURES 2B - 2D depicts control track pulses, including various inventive embodiments, recorded on a medium.

FIGURES 3A - 3C show various control track pulse waveforms including pulse width modulation by supplementary information.

15 FIGURE 4A shows the recorded pattern of FIGURE 2A.

FIGURE 4B shows an inventive tape speed control sequence facilitating trick play reproduction.

FIGURE 4C depicts a trick play frame sequence resulting from the control sequence illustrated in FIGURE 4B.

20 FIGURE 5 is an exemplary flow chart illustrating an inventive trick play method for anticipating a track containing an I frame.

DETAILED DESCRIPTION

A simplified consumer digital audio video system is illustrated in FIGURE 1. A receiver, IRD 100, is depicted coupled to a receiving antenna 50, however, an RF modulated signal may be provided from a cable distribution network (not shown). The modulated packetized signal is tuned, demodulated and a user determined program separated within the receiver packet selector block indicated as RCV. PKT. SEL. 55. An output from the receiver packet selector 55 comprises a transport packet stream of audio video and control data which is MPEG decoded by DECODER 117. The MPEG decoder operates in conjunction with a memory, MEM. 116, which stores several frames including the last I frame. In the event of an MPEG data stream loss or mangled MPEG syntax, decoder 117 and memory 116 are controlled by controller 115 to sustain output signal generation by repeating a preceding frame from memory 116. Thus

25

30

35

09260684-033099

- 5 -

data stream loss or distortion, for example, due to rain fade, replay data loss, drop out or distortion, causes the last frame to be duplicated, producing a frozen or still frame image, for the duration of the data outage. The decoder generates audio and video signals which are coupled to output block O/P 118 which produces analog audio and video output signals, 101 and 104, which are coupled for monitoring by display 300.

Replay packet source 200, which may for example, conform to the D-VHS or DVC recording formats, is illustrated in the simplified exemplary block diagram of FIGURE 1. As described previously, cost considerations may dictate that digital recorder 200 does not include MPEG encoding and decoding. Hence digital recorder 200 functions as a bit stream recorder/player, and provides time shifting or program delay capability. The omission of MPEG decoding and the degree of complexity required to facilitate non-standard speed replay capability, renders image reproduction difficult at speeds other than play speed. In summary, receiver IRD 100 couples an MPEG compatible packet stream via digital A/V bus 112 for recording by recorder 200. Similarly a replay packet stream is coupled via bus 112 to receiver IRD 100 for MPEG decoding, and audio/video generation.

Player recorder 200, illustrated in FIGURE 1, receives demodulated transport packets from receiver IRD 100 via bi-directional data bus 112. The transport packet stream is formatted for bus transmission, for example as a superpacket with superpacket header, and coupled to data bus 112 via an interface port 110. The formatted transport packet is received at recorder 200 by means of interface port 210 which derives a record bit stream 211. The interface ports are controlled by a control data stream carried on a separate conductor included with data bus 112. Control signals may be derived from user input by activation of control switches (not shown), or by user generated remote control commands.

The record bit stream 211 is coupled for processing by recording block DIG. REC. 215. Digital recording block 215 includes a buffer memory which is utilized to smooth the intermittent delivery of transport packets to produce a signal more suited for recording. The buffered data stream is read from the buffer memory to form

- 6 -

sync blocks which may be encoded with error detection / correction data words. The sync block formatted data stream may be modulated for recording as described, and coupled from recording block DIG. REC. 215 via a selector switch A4. Selector switches A4 and A5 are controlled responsive to the selected D-VCR operating mode. For example, switches A4 and A5 are shown positioned for digital operation, with digital recording signals routed by switch contacts DR, digital playback data routed by switch contacts DP. A record play switch A6 couples data stream 251a to and from transducer heads 10 251 located on rotating head assembly 250. Analog operation is facilitated by the alternate positions of switches A4 and A5, designated analog record AR, and analog playback AP. Sync block formatted data from recording block DIG. REC. 215 is coupled to rotating head assembly 250 for recording by heads 251 on a magnetic 15 tape 249.

During replay operation, sync block formatted data is reproduced from the magnetic tape 249 by transducing heads 251 positioned on assembly 250. The recovered signal is demodulated by digital replay block DIG. REP. 220, to remove any recording channel 20 modulation. The replay signal is then subject to error detection and correction by means of the data words inserted prior to recording. Following error correction, the sync block formatting is removed and the transport packet stream restored to have substantially the same the packet format and timing as that coupled to the recorder for 25 recording. The transport packet stream from block DIG. REP. 220 is coupled to interface port 210 which, responsive to the recorder play mode couples the packet stream to the bi-directional data bus 112 for MPEG decoding by decoder 117.

Player recorder 200 includes a servo control system 30 represented within dash line box 201. During analog operation synchronizing signals AS are separated from the analog signal to be recorded in analog record processor block 240, and are coupled to synchronize sync generator 285. Synchronization is required to ensure that servo block 280 controls rotation of the capstan motor 35 255 and rotary head motor 246 in synchronism with the analog video signal. In simple terms the capstan must pull the tape at a constant rate locked to the analog signal and the rotary head must write the

09266684-033099

-7-

analog signal at predetermined media locations. However, unlike analog signals, the MPEG packet stream cannot readily provide synchronizing signal AS required for servo system control of recorder 200. Hence during digital operation servo system 201 utilizes synchronizing signals generated by synchronizing generator 285 which is referenced to a crystal oscillator X. Thus sync generator 285 provides stable control signals which ensure that head assembly 250 is locked and synchronized at 30 revolutions per second and the tape is transported at substantially the same speed as during analog operation.

In addition to smoothing the intermittent delivery of transport packets, the buffer memory of recording block 215, enables the output signal 216 to be recorded at predetermined locations on tape 249. For example, buffer memory may be read out in synchronism with rotation of head assembly 250. Similarly each video data sync block, formatted from the buffer may be read out to have a specific location in each recorded track. Synchronization of the buffer memory of block 215 is provided by a control signal, CTRL. 1 generated by controller 205.

As is known in analog recording, the recording head assembly 246, 250 and capstan motor assembly 253, 555 are servo controlled to rotate in synchronism one with the other, and in synchronism with an analog sync signal. During digital recording, the head and capstan motors may be referenced to the crystal controlled synchronizing generator 285. To ensure replay synchronism between the capstan and video head drum a control track is recorded along a bottom tape edge as shown in exemplary FIGURE 2A. Control track pulses are, for example, derived from the head drum and consequently have a repetition rate 30 Hz. Thus for each head drum revolution a control track pulse marks one track, for example having an azimuth angle Θ_1 . Since the head drum employs two heads spaced by 180 degrees, nominally 60 tracks are recorded per second. The recorded control track signal is illustrated in FIGURE 2B and shows a control track pulse marking the start of alternate tracks. Twelve frame groups of pictures are illustrated in FIGURE 2A, and for simplicity, longitudinal audio tracks and transverse track angles are not shown.

- 8 -

Reproduction at speeds other than normal play speed may be advantageously facilitated by use of a stored automated play control sequence which alternates recorder control modes between normal play speed and fast play speed operation. During fast play operation the capstan pinch roller 254 remains engaged with capstan 253 and the rotational speed is increased and maintained under servo control. For example in FIGURE 2A, 12 frame groups of pictures are illustrated, repeating on average every 24 tracks with the first two tracks depicted with I frame data. If normal play speed operation is initiated from any location in the track patterns of FIGURE 2A, I frame data must be recovered within 24 tracks or twelve control track (CT) pulses. Thus in the automated control sequence described above, normal play speed operation may be activated for a duration of 12 CT pulses and fast play, for example at four times speed, selected for approximately 256 control track pulses. Hence this exemplary automated trick play sequence will sample the recorded tracks approximately every 2 seconds, which corresponds to approximately 8.5 seconds of elapsed tape or program time at 30 Hz drum rates or about 10 seconds with 25 Hz speeds. Thus a forward search trick play mode is provided which comprises a series of still I frames images spaced by nominally 8 - 10 seconds of elapsed program time. During fast play periods the reproduced MPEG syntax may be mangled and the data stream lost, however, IRD decoder 117 and memory 116 advantageously sustain the output signal by repeating the last preceding frame from memory. A reverse search trick play mode may be similarly provided where capstan rotation is reversed for the period of the exemplary 256 control track pulses. However, such reverse tape motion requires controlled operation of the take up and supply tape reels to prevent slack, or over tensioning causing tape damage.

In a further advantageous embodiment controller 205 receives control data signal 202 from bus interface 210 via control line 202a. Control data signal 202 is generated within IRD 100 and includes a signal component IF which marks the occurrence of an I frame in the transport packet stream coupled for recording. Intra-frame marker signal IF may be communicated to recorder 200 by means of a header added to a superpacket employed for transport

00260684-037009

-9-

packet bus communication, or as a separate control signal coupled via bus 112. The superpacket header is read by digital recording block 215 and IF marker extracted and sent to controller 205 via control line 205a. In an alternative arrangement digital recording block 215 may filter bit stream 211 to determine an intra-frame occurrence by extracting picture header information from GOP and sequence headers. Controller 205 may employ the I frame marker signal IF together with head and capstan phase information to form control signal CTRL 1. Control signal CTRL 1 controls read out from the buffer memory of block 215 to ensure that I frame data recording is initiated in tracks of the same recorded azimuth. Thus the inventive use of I frame marker IF ensures that each I frame recording is initiated in tracks of the same recorded azimuth angle.

In exemplary FIGURE 2A, a magnetic tape 249 is shown recorded with an MPEG representative signal having a group of pictures size of 12 frames. Intra-coded data is shown with horizontal shading in FIGURE 2A, and is depicted with recording initiated in track 1, with an azimuth phase angle $\emptyset 1$ and continuing into track 2 with an azimuth angle $\emptyset 2$. Forward predicted, or P frame data, is recorded in track 3 with an azimuth angle $\emptyset 1$, and is shown shaded diagonally. The remaining 9 frames of this exemplary 12 frame GOP are written in the following unshaded track area. Since the recording head drum rotates at 1800 RPM and has two heads diametrically opposed, nominally 60 tracks are written per second. Thus the GOP size of 12 frames is illustrated occupying 24 tracks. However, since the amount of data present in each compressed frame varies in accordance with motion and scene complexity, the actual duration of individual frames may vary. Hence the duration of a GOP may vary and thus require that unfilled recording track capacity be filled with zeros. In the simple recorded track patterns of exemplary FIGURE 2A, I frame data may or may not completely fill the data capacity provided by tracks 1 and 2, hence P frame data recording may be initiated in track 2 and continue in track 3. Similarly for the remaining frames of the group of pictures, which are written consecutively and may be distributed between adjacently recorded tracks. In addition, GOP size is user defined and may be changed at will with a new GOP being initiated with an I frame. Hence the

-10-

advantageous coupling of I frame marker IF ensures that each I frame recording is always initiated with the same azimuth phase. For example, in FIGURE 2A I frame tracks have an azimuth $\emptyset 1$ and are indicated with a control track pulse, as shown in FIGURE 2B. Control track pulses are, for example, derived from the head drum, have a repetition rate 30 hertz and mark one track of each pair, for example $\emptyset 1$, for each head drum revolution.

In a further inventive embodiment, trick play reproduction may be advantageously facilitated by controlled reproduction of only tracks containing intra-coded or I frame data. Since I frame marker IF, determined the recorded track selection i.e. azimuth $\emptyset 1$ or $\emptyset 2$ and control track pulses mark alternate tracks, tracks containing I frame data may be advantageously identified for reproduction. To facilitate replay identification of I frame data, specific control track pulses are advantageously modulated during recording with signal A which is derived, as described previously, from the occurrence of I frame data in recording bit stream 211. Thus signal A modulates the control track signal to mark tracks containing I frames. FIGURE 2C shows an enlarged section of the control track signal depicted in FIGURE 2B. The section shown in exemplary FIGURE 2C is centered, for example, about an I frame recorded in track 25, and illustrates a sequence of reproduced control track pulses. Pulse A, shown with a solid black section, marks I frame track 25 and has been advantageously pulse width modulated during recording to specifically indicate I frame data tracks.

In the VHS format control track pulse width modulation is known and used to facilitate searching with systems such as Video Index Search Signal (VISS) or Address Search Signal or (VASS). However to summarize, control track pulse width modulation operates as follows. During replay the rising edges of the control track signal, depicted by arrow heads in FIGURE 3A, are used for playback speed control. However the trailing, non-time critical edge of the control track pulse may be controllably phase shifted or repositioned. Data may be encoded by varying the phase or position of the trailing edge of the recorded control track signal between two distinct phases, or positions representing digital true and false or one and zero value data bits.

- 11 -

FIGURE 3A depicts a standard control track pulse signal having a nominal pulse width duty cycle of between 50% to 60%. FIGURE 3B depicts a phase modulated control track pulse showing both logical "1" and logical "0" values. A logical "1" is encoded, for example, by advancing the phase of the trailing edge, thus shortening the positive portion of the control pulse to a duration of about 27.5% of the pulse repetition period. A logical "0" value delays the trailing edge as compared to a nominal 50% duty cycle, for example to produce a pulse of 60% duration. FIGURE 3C illustrates phase modulated control track pulses shaped for recording. Simple timing and gating circuits can distinguish between pulses having a duty cycle that is longer or shorter than a reference duration (e.g., 50%).

Additional control track identification may be advantageously provided to indicate tracks containing, for example, forward predicted frames, P frames or bi-directional encoded frames, B frames. Such additional data may indicate P and or B frames by additional pulse coding between 28% to 60 % duty cycle of the control track pulse. Such P and or B frame indicators may, to simplify detection, follow and be enabled by, an occurrence of a preceding I frame coded control track pulse. For example FIGURE 2D shows an enlarged section of the control track signal is centered about I frame track 25 as depicted in FIGURE 2A. A sequence of reproduced control track pulses are illustrated in FIGURE 2D with pulse A marking 25, and pulse B, shown with horizontal shading, advantageously width modulated to indicate P frame data tracks, for example track 27.

The advantageous use of control track pulse modulation enables recorded tracks to be identified during reproduction at play speed and speeds other than play speed. Thus specific tracks, for example, intra coded data or intra coded and forward predicted data, may be identified and reproduced. Tracks identified as non-decodable in trick play, and hence unwanted, may be passed with increased tape speed. By identifying recorded track content, an inventive method of trick play reproduction is facilitated where decodable data, for example, intra coded, or intra coded and forward predicted data may be replayed at normal speed, with unwanted data tracks being passed at an increased tape speed. The media and recorded signals of FIGURE 2A are shown in FIGURE 4A. FIGURE 4B

09265684-03309

- 12 -

illustrates an exemplary automated trick play tape speed profile having areas of differing tape speed, S, P, A, F, and D occurring at various times. For example, area S corresponds to a stopped tape condition prior to reproduction. Area P represents normal play speed operation which is sustained for the duration of the intra coded data, which in this example is assumed to be contained in two recorded tracks, 1 and 2. Since the modulated A pulse marks the start of an I frame, the actual recorded duration is not marked, hence the play mode, indicated by area P, may be sustained for two or more control track counts. Following the control track count determining area P the tape is accelerated, during area A to be transported at a higher speed, for example four times. The exemplary automated trick play tape speed profile of FIGURE 4B illustrates a fast play condition, area F, of duration nominally 5 tracks or approximately 2 CT pulse counts.

Such a short duration may be difficult to implement due to the mechanical constraints of capstan inertia and tape and reel masses. However, the automated speed profile illustrated in FIGURE 4B may be modified to accommodate specific recorder mechanisms. The automated trick play sequence illustrated in FIGURE 4B may result in a sequence of decoded frames as depicted, horizontal, vertical and temporally in FIGURE 4C. Clearly the number of repeated frames is determined by the availability of a newly reproduced decodable data stream. If only I frames of FIGURE 4A were reproduced the program would be viewed at twelve times normal speed, assuming a 12 frame GOP. If a reproduced frame is held or repeated for approximately the duration of a GOP then there is no actual or perceived speed up in program delivery and the recorded moving images are effectively represented as a series of stills. Thus in example of FIGURE 4A the program delivery rate is increased by slightly more than two times.

The reproduced occurrence of I frame marker pulse A may be used to initiate a count of succeeding non-modulated control track pulses to determine or predict the occurrence of the next automated play sequence. Fast play duration in excess of one GOP may be facilitated by counting A pulses then decelerating to assume a normal play speed prior to the occurrence of the next I frame.

As previously described, the control track signal may be modulated to yield pulse A, which may advantageously be further

09269234-033059

-13-

utilized by recorder control logic 205 to inventively determine an average length of reproduced groups of pictures. For example, during a normal play back condition control logic 205 may receive signals from control track processor 208 indicative of reproduced I frames.

- 5 These I frame markers may be used to adaptively measure the length or duration of reproduced groups of pictures or GOPs by counting the number of control track pulses occurring between I frame markers. The replay GOP lengths may be averaged and processed, for example, by subtraction to provide anticipation of the next I frame and to
10 account for media deceleration as indicated by area D of FIGURE 4B.

- FIGURE 5 is an exemplary flow chart which illustrates an inventive method for dynamically and adaptively anticipating a replay occurrence of a track containing an I frame. In FIGURE 5 a play mode is selected at step 100 and as described the recorded
15 signal is reproduced however decoding may not occur until an I frame is reproduced. At step 200 the replay I frame or alternatively the control track I frame marker pulse A is measured to determine an average interval between I frames or marker pulses. This average interval value represents the duration of each group of pictures (GOP) and is averaged to reduce or remove effects of shortened or variable
20 GOPs. At step 200, I frames or marker pulses enable or gate the summation or count of reproduced control track pulses thus provided a direct linear measurement of the duration of each GOP. The control track pulse count is averaged and a value N determined. Thus, since
25 control track pulses are recovered during fast play or shuttle modes the next track containing an I frame may be located and accessed by counting CT pulses. However, since the replay apparatus and recording medium exhibit inertia the average value N is processed at step 300, for example by subtraction of a deceleration value D to
30 yield a lesser CT pulse count value which anticipates the occurrence of the next I frame track and allows for capstan servo deceleration and track acquisition. Different deceleration values are employed in relationship with the fast play or shuttle speed. Thus at step 300 the replay apparatus is in a play mode and determining an average
35 CT pulse count value to the next I frame. At step 400 a test is performed to determine the selection of a trick play mode. A NO at step 400 forms a loop which waits until trick play is selected which

09255634-033009

- 14 -

results in a YES. The YES at step 400 sets, enables or loads a counter at step 500 with the value (N - D). The counter is decremented at step 600 with reproduced control track pulses and tested at step 700 for a zero value. The trick play mode is maintained for non-zero counts by a NO at step 700 which loops back to step 400. However when step 700 tests YES the next track containing a recorded I frame is anticipated and a play mode is initiated at step 800. Steps 400 to 800 are repeated by the occurrence of the reproduced I frame or control track marker pulse A which sets or loads the counter at step 500. The trick play mode is terminated when step 400 tests NO, for example, responsive to user command.

The method depicted in exemplary flow chart of FIGURE 5 employs control track pulses which marked during recording to indicate the recorded occurrence of an I frame. However in another inventive embodiment the exemplary method of FIGURE 5 may be utilized with recordings without control track I frame marker pulses. Tapes without control track marker pulse A may be played following the steps depicted. However, determination of average GOP size, step 200, in terms of control track pulse count is facilitated by means of I frame markers or pulses, for example signal IFR derived from the derived from the decoded reproduced MPEG data stream by, for example IRD 100. The replay I frame signal IFR is coupled, as has been described, to controller 205 and is processed to establish an average value of GOP size. When trick play operation is selected an automated trick play control sequence is read from memory with the control sequence initiated by the occurrence of I frame signal IFR which sets the counter at step 500. The period between normal speed reproduction being determined by the processed average GOP value as described earlier. Thus recordings without I frame encoded control tracks may be replayed in a trick play operating mode.

09260604.033009

- 15 -
CLAIMS

1. A record and replay apparatus comprising:
transducing means for reproducing a digital signal from a
5 medium;
a control means for controlling a reproduction mode of
said apparatus;
means coupled to said transducing means for decoding
said digital signal and deriving therefrom a signal indicative of a
10 specific picture type; and,
said reproduction mode having a first period of
reproduction at a normal play speed and a second period of
reproduction at a speed greater than said play speed, said first and
second periods alternating with said first period initiated responsive
15 to said signal indicative of a specific picture type.
2. The recording and replay apparatus of claim 1, wherein said
second period of reproduction occurs during reproduction in one of a
forward and a reverse direction.
- 20 3. The recording and replay apparatus of claim 1, wherein said
digital signal represents an MPEG stream.
4. The recording and replay apparatus of claim 1, wherein said
25 specific picture type corresponds to an intra coded frame.
5. The recording and replay apparatus of claim 1, wherein said
control means is responsive to a stored sequence having alternating
play and fast play modes.

09565684-033099

- 16 -

6. A record and replay apparatus comprising:
a source of an MPEG bit stream signal coupled to an input of said apparatus for recording;
- 5 a first transducing means for recording a digital signal representative of said MPEG bit stream;
a control means coupled to said MPEG bit stream signal and generating a signal indicating an intra coded frame occurrence in said MPEG bit stream;
- 10 a second transducing means for recording and reproducing a reference signal; and,
means responsive to said indicating signal for generating an identifying signal for recording with said reference signal.
- 15 7. The recording and replay apparatus of claim 6, wherein said first transducing means reproduces said recorded signal in a reproducing mode comprising a sequence of play and fast play modes responsive to a stored sequence of play and fast play mode commands controlled by said control means.
- 20 8. The recording and replay apparatus of claim 7, wherein said control means initiates said reproducing mode responsive to said identifying signal coupled from said second transducing means.

09260634-03009

- 17 -

9. A recording and replay apparatus comprising:
a source of an MPEG bit stream signal coupled to said
apparatus for recording;
5 means coupled to said MPEG bit stream signal for
generating a record signal representative of said MPEG bit stream
signal;
a pair of record transducers each aligned for recording
said record signal and having complementary azimuth angles; and,
10 a control means coupled to receive a signal identifying an
intra coded frame occurrence in said MPEG bit stream signal and
controllably coupled to said generating means, wherein responsive to
said identifying signal said control means enabling a record signal
representative of an intra coded frame part of said MPEG bit stream
15 for recording by one of said transducer pair having a specific azimuth
angle.
10. A recording and replay apparatus comprising:
a source of an MPEG bit stream signal coupled to said
20 apparatus for recording;
means coupled to said MPEG bit stream signal for
generating a record signal representative of said MPEG bit stream
signal
a record transducer pair having complementary azimuth
25 angles for recording said record signal;
a recording head coupled to a control track signal
generator and generating a control track signal for recording;
a control means for receiving a signal identifying an intra
coded frame occurrence in said MPEG bit stream signal, said control
30 means being controllably coupled to generating means and to said
control track signal generator; and,
responsive to said identifying signal said control means
enabling said generating means for coupling a record signal
representative of an intra coded frame part of said MPEG bit stream
35 for recording by one transducer of said transducer pair having a
specific azimuth angle, and responsive to said identifying signal said
control means modifies said control track signal for recording.

-18-

11. An apparatus for recording and reproducing digital signals from a medium, said apparatus having a trick play reproduction method comprising the steps of:

- 5 a) sensing recorded I frame information;
 b) playing said recorded I frame information;
 c) initiating a fast play mode;
 d) sensing subsequent recorded I frame information;
 e) playing said subsequent recorded I frame information;
10 and,
 f) controlling transitions between said play and said fast play modes responsive to a predetermined sequence.

12. The apparatus of claim 11, wherein said step a) comprises:
15 sensing a recorded signal indicative of said recorded I frame information.

13. The apparatus of claim 11, wherein said step c) comprises:
20 servo controlling motion of said medium during said fast play mode.

14. The apparatus of claim 11, wherein said step f) comprises:
 initiating said predetermined sequence responsive to said
25 recorded signal indicative of said recorded I frame information.

15. A recording and replay apparatus with trick play reproduction mode comprising the steps of:
 a) initiating a play mode;
 b) determining an average number of control track pulses
30 occurring between I frames;
 c) selecting a trick play mode;
 d) counting control track pulses to determine an average value;
 e) testing a count for equality with said average number; and,
 f) initiating said play mode at count equality.

- 35 16. The recording and replay apparatus of claim 15, wherein said step b) additionally comprises:

The diagram illustrates a magnetic tape head assembly. On the left, a vertical arrow labeled "HEAD MOTION" points upwards. The tape itself is represented by a series of horizontal lines, with some sections shaded with diagonal lines. A bracket labeled "249" spans a portion of the tape. Below the tape, several horizontal arrows point to the right, labeled from top to bottom: "I FRAME", "P FRAME", "CONTROL TRACK", "TRACKS", "AZIMUTH", and "TAPE MOTION". To the right of the tape, a vertical axis is labeled "1 SEC." at the top. Along this axis, a series of numbers are listed: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62. A dashed arrow points to the right from the "TRACKS" label, and another dashed arrow points to the right from the "AZIMUTH" label.

3/5

FIG. 3A

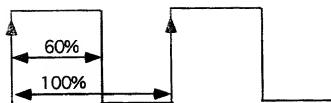
STANDARD
CONTROL
TRACK
PULSES

FIG. 3B

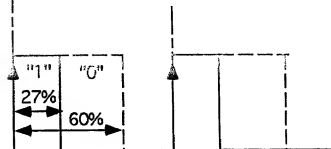
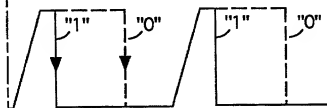
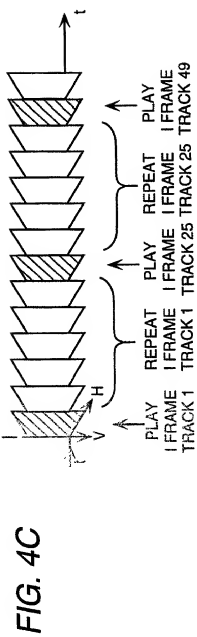
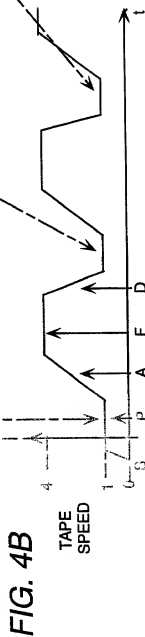
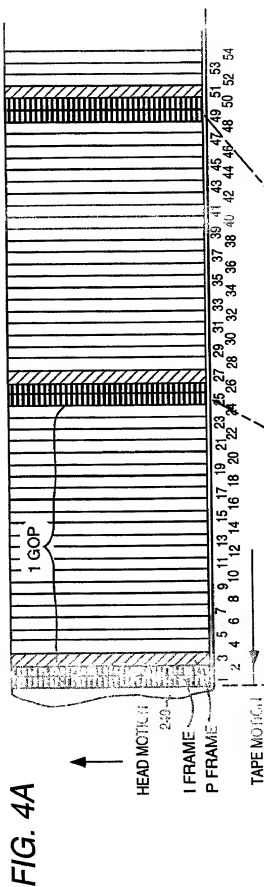
CODED
CONTROL
TRACK
PULSES

FIG. 3C

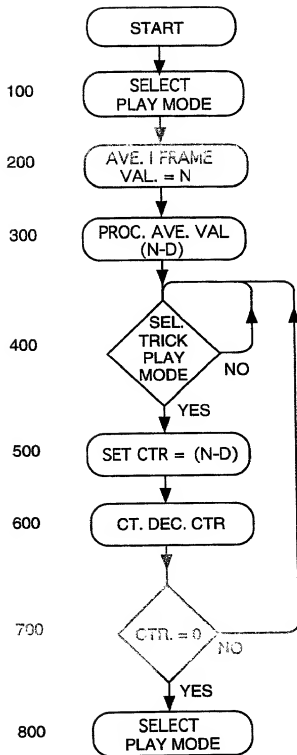
CONTROL
TRACK
DATA
PULSES09269684-03009
660330-16969260

4/5



5/5

FIG. 5



09269684-033099

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY

(Includes Reference to PCT International Applications)

ATTORNEY SOCKET NUMBER

RCA 88423

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

DIGITAL RECORDER WITH TRICK PLAY OPERATION

the specification of which (check only one item below):

☐ is attached hereto.☐ was filed as United States application

Serial No. _____

on _____

and was amended

on _____ (if applicable).

☒ was filed as PCT international application

Number PCT/US97/18167

on 08 October 1997

and was amended under PCT Article 19

on 03 April 1998 (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY (if PCT, indicate PCT)	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119
GB	9620923.4	08 October 1996	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO

Combined Declaration For Patent Application and Power of Attorney (Continued)

(Includes Reference to PCT International Applications)

 ATTORNEY'S DOCKET NUMBER
RCA 88423

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. 120:

U.S. APPLICATIONS		STATUS (Check one)		
U.S. APPLICATION NUMBER	U.S. FILING DATE	PATENTED	PENDING	ABANDONED
PCT APPLICATIONS DESIGNATING THE U.S.				
PCT APPLICATION NO.	PCT FILING DATE	U.S. SERIAL NUMBERS ASSIGNED (if any)		
PCT/US97/18167	08October1997 (08.10.97)			

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (List name and registration number)

Joseph S. Tripoli	- Reg. No. 26,040
Joseph J. Laks	- Reg. No. 27,914
Francis A. Davenport	- Reg. No. 36,316
Daniel E. Sragow	- Reg. No. 22,856

Send Correspondence to:

Mr. Joseph S. Tripoli - Patent Operations
THOMSON multimedia Licensing Inc.
PO Box 5312
Princeton, New Jersey 08543US

Direct Telephone Calls to:

(name and telephone number)
1-609-734-9864

	FULL NAME OF INVENTOR	FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
201	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
		Indianapolis IN	Indiana	US
	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY	
	2220 Brewster Road	Indianapolis	IN 46260 US	
202	FULL NAME OF INVENTOR	FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
		Indianapolis IN	Indiana	US
	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY	
	2713 Grassy Creek Court	Indianapolis	IN 46229 US	
203	FULL NAME OF INVENTOR	FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
		Indianapolis IN	Indiana	US
	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY	
	720 Sherwood Drive	Indianapolis	Indiana 46240 US	

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
Harold Blatter	Karl Francis Horlander	Michael Joseph McLane
DATE	DATE	DATE
March 22, 1999	March 16, 1999	March 16, 1999